Chapter 6: Agriculture

1 Overview and Key findings

- Close to 80% of all farmland in the Delta is classified as "Prime Farmland", the California Farmland Mapping and Monitoring Program's highest designated tier.
- Total cropped acreage in 2010 was 419,891 acres, not including approximately 38,000 acres of grazing land.
- The top five Delta crops in terms of acreage are: 1) Corn, 2) Alfalfa, 3) Processing Tomatoes, 4) Wheat, and 5) Wine Grapes.
- Total crop value in 2009 was approximately $660 million dollars. Truck and vineyard crops account for 56% of crop revenues on 17% of acreage.
- The top five Delta crops in terms of value are: 1) Processing Tomatoes, 2) Wine Grapes, 3) Corn, 4) Alfalfa, and 5) Asparagus.
- The highest per-acre values in the Delta come from truck crops mainly situated in the southern Delta and deciduous crops principally located in the northern Delta.
- The approximately $660 million in Delta crop production and $90 million in Delta animal and animal product revenue has an economic impact of 9,250 jobs, $635 million in value added and $1.3 billion in output in the five Delta counties. Across all of California, the economic impact of Delta agriculture is 12,360 jobs, $761 million in value added, and $1.5 billion in output.
- When regional canneries and wineries that are tightly linked to Delta crops are included with crop and animal production, the total economic impact of Delta agriculture is 13,700 jobs, $1.1 billion in value-added, and nearly $2.8 billion in economic output in the five Delta counties. In addition, Delta agriculture supports nearly 23,000 jobs, over $1.9 billion in value-added, and over $4.6 billion in economic output in the state of California.
- The long-run land allocation forecast in the baseline scenario predicts a future increase in truck crops, and decreases in field and grain crops. Despite a potential 10% decline in field and grain crop acres, these crops would still dominate Delta agriculture acreage. This shift of 10% of land to higher value crops could lead to an approximately $115 million gain in crop revenues.
- The effect of isolated conveyance on salinity is highly uncertain at this time. The preliminary estimate of losses from increased salinity is between $20 million and $65 million per year. The loss of farmland to construct the conveyance facility is

estimated to generate an additional $10 to $15 million in crop losses per year. Salinity losses could be much higher if a 15,000 cfs conveyance were operated to increase water exports beyond the levels proposed in the draft BDCP.

- The agricultural impacts of most of the BDCP conservation measures are difficult to quantify due to the lack of precision in site specification and other details. Broad ranges of potential annual crop losses have been calculated from the land requirements and descriptions of easement costs in the draft BDCP.
    - Tidal habitat restoration losses range from $18 to $77 million annually with lower losses when restoration is targeted to Suisun Marsh.
    - Natural Communities Protection losses are estimated to range from $5 to $43 million annually depending on targeting of high-value, permanent crops.
    - San Joaquin River Floodplain crop losses are estimated at $15 to $20 million annually, but could be reduced up to 80% by implementing an alternative proposal to expand an existing bypass at Paradise Cut.
    - Yolo Bypass Fishery Enhancements could generate crop losses between $1 and $5 million annually.

2 Current Status and Trends

2.1 Mapping Delta Agriculture

Delta agriculture is part of a complex and constantly-changing landscape, and it presents many challenges to precise measurement. Over the past few years, studies and data-collection by a range of State and federal agencies have yielded results which provide a detailed overview of the Delta's diverse agricultural backdrop. The use of empirical techniques such as satellite imaging, digitization of farm records, field surveys, and public review have accumulated a wealth of information pertinent to policymaking. None of the data sources described below is complete in itself, but collectively leveraged, they create the best available picture of the Delta agriculture and its broad role in the Delta economy.

2.1.1 Land Use Data

Field Borders

California law requires full reporting of agricultural pesticide use/ Each Delta county collects information from farmers on all crop fields in which pesticide applications are conducted. Through the use of geographic information system (GIS) software, four of the Delta counties digitally map that data to form a mosaic of agricultural fields within their borders. This data is extremely useful, as it provides recent data on fields intended for actual use and harvest, and includes specific information on the crops each land manager intends to grow in the coming year. This data enables this analysis of Delta agriculture at an extremely granular level, that of the individual crop field. Approximately 90 percent of Delta acreage in this study is represented

at this level. One challenge presented by this data is that though the vast majority of crop fields have some form of pesticide application, the small percentage that do not is not included and must be estimated by other means.

National Agricultural Statistics Service

For the two counties which do not digitally map their field borders, satellite remote sensing data captured and made available by the National Agricultural Statistics Service (NASS) provides good information. The data collected by this agency is applied in a wide range of agricultural applications, and the accuracy of the methods used to determine crop type is quantified in detail. Though less accurate than direct field borders reporting, this data shows agriculture not permitted for pesticide use, and provides a means to survey Delta land not covered by field borders.

Farmland Mapping and Monitoring Program

For estimates of total farmland acreage, GIS data collected by the California Farmland Mapping and Monitoring Program (FMMP) was employed. This state program uses a combination of satellite imagery, public review, and field surveys to produce a complete map of the state's agricultural lands. FMMP maps were leveraged by making use of their categorization of grazing land. Though grazing land is not actively farmed, it is sometimes incorrectly captured in the NASS data as active pastureland; close examination of areas marked by FMMP as grazing land eliminated such errors.

National Agriculture Imagery Program

Public satellite imagery provided by the National Agriculture Imagery Program is used to resolve major inconsistencies between the previously described data sources. While it is impossible to eliminate the more minute discrepancies, for large acreage areas in which conflicts are noted, NAIP photos allow a direct look at the area in question in order to ascertain into what land-use category a parcel should be attributed.

2.1.2 Revenues, Profits, and Costs Data

County Crop Reports

In order to determine aggregate revenues from Delta crop production, crop yield and price figures published in each county's annual crop report were used. Though the values used in reporting are collected through a variety of sources and represent average yields for the entire county, they offer the most practical means of determining total revenues from Delta agriculture. Where possible, outside sources were consulted to obtain more accurate values for Delta-specific agriculture. These sources are described below.

University of California Cost and Return Studies

The University of California Cooperative Extension prepares extremely detailed studies on the costs and returns associated with establishing and maintaining various crops in different regions of the state. Where available, this analysis drew from the UC Cooperative Extension studies conducted in Delta regions to calculate various costs and profits expected from different agricultural operations in the Delta region.

2.2 Crop Categories

In order to facilitate presentation and analysis of Delta agriculture, it is necessary to categorize crops into a limited number of discrete categories. In addition to enabling the use of econometric techniques for forecasting future land use, these categories allow for the broader overview of Delta agriculture, presented in the tables and maps throughout this report. Examples of major Delta crops from each category are outlined in Table 5 below, and the full crop category table is in Appendix E.

Table 5 Crop Category Examples

Deciduous	*Pear, Almond, Walnut, Cherry*
Field	*Corn, Safflower, Dry Beans*
Grain	*Wheat, Oats, Barley*
Pasture	*Alfalfa, Pastureland*
Truck	*Tomato, Asparagus, Potato, Blueberry*
Vineyard	*Grapes*

2.3 Delta Agricultural Acreage

Total Farmland Acreage

All agricultural production in the Delta is dependent on high-quality farmland able to support it. Adequate soil quality, moisture, and temperatures are just a few of the characteristics necessary to support sustainable high yields. FMMP mapping uses a tiered system of farmland categories which provide a comprehensive view of agriculture suitability around the Delta. Since FMMP surveys are updated every two years, they also allow observation of the continuing effects of urban growth and expansion on agricultural farmland. The table and figure below offer a snapshot of Delta farmland in 2008, the most recent year from which FMMP maps are available. The total size of available farmland in the Delta is 500,383 acres, with almost 80 percent of the total acreage designated in the FMMP's top tier of "Prime Farmland."

Table 6 Total Farmland Acreage, 2008

County		Class	
San Joaquin	267,741	Prime Farmland	396,554
Sacramento	71,722	Farmland of Statewide Importance	33,360
Yolo	54,644		
Solano	53,509	Unique Farmland	29,525
Contra Costa	49,685	Farmland of Local Importance	40,944
Alameda	3,082		
Total	**500,383**	**Total**	**500,383**

Harvested Acreage and Crop Allocation

This analysis places the total number of Delta acres in agricultural production in 2010 at 457,444 acres. Acreage includes all irrigated crops and pastureland, and grazing land. Table 7 depicts the total acreage of each crop category by county, as well as totals for the entire Delta. Table 8 depicts the largest crops by total acreage.

Table 7 Delta Agricultural Acreage, 2010

Crop Class	San Joaquin	Sacramento	Yolo[1]	Solano[1]	Contra Costa[2]	Alameda[2]	TOTAL
Deciduous	7,127	6,902	816	486	1,426	82	**16,839**
Field	86,673	24,393	8,118	11,663	13,319	5	**144,171**
Grain	19,579	5,518	5,806	8,407	10,056	2,263	**51,629**
Pasture	51,976	14,992	16,034	30,557	15,850	1,008	**130,417**
Truck	37,788	3,482	3,519	1,258	215	4	**46,266**
Vineyard	10,477	8,295	9,194	1,528	1,074	1	**30,569**
Grazing Land[3]	433	2,846	11,499	18,600	2,284	1,991	**37,653**
TOTAL	**214,053**	**66,428**	**54,986**	**72,499**	**44,224**	**5,354**	**457,544**

[1] Pasture acreage adjusted using NASS estimates

[2] NASS data used due to lack of recorded field borders

[3] Grazing land acreage estimated from 2008 FMMP data

Table 8 Top 20 Delta Crops by Acreage, 2009

	Crop	Acreage	Value
1.	Corn	105,362	$92,975,715
2.	Alfalfa	91,978	$66,027,076
3.	Processing Tomatoes	38,123	$117,242,615
4.	Wheat	34,151	$17,549,215
5.	Wine Grapes	30,148	$104,990,142
6.	Oats	15,847	$4,195,540
7.	Safflower	8,874	$3,312,014
8.	Asparagus	7,217	$50,050,037
9.	Pear	5,912	$36,746,649
10.	Bean, Dried	5,493	$3,990,318
11.	Rice	4,874	$6,822,488
12.	Ryegrass	4398	$1,061,436
13.	Cucumber	3,737	$7,866,553
14.	Potato	3,353	$28,605,465
15.	Almond	3,121	$8,776,101
16.	Sudangrass	3,025	$1,398,634
17.	Walnut	2,512	$9,453,874
18.	Pumpkin	2,103	$7,926,038
19.	Watermelon	1,717	$7,953,590
20.	Cherry	1,486	$11,490,843

Figure 18 FMMP Delta Farmland Coverage

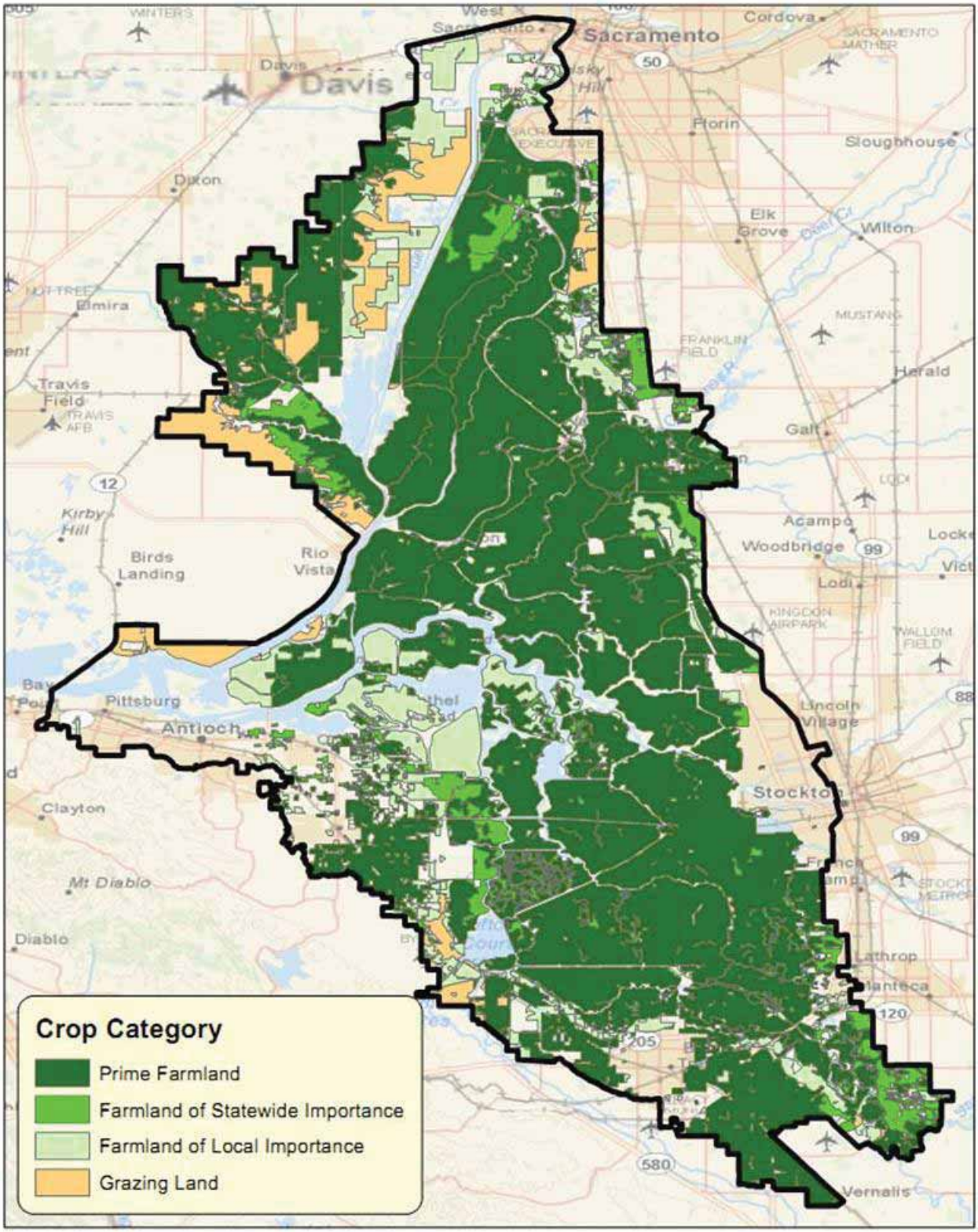
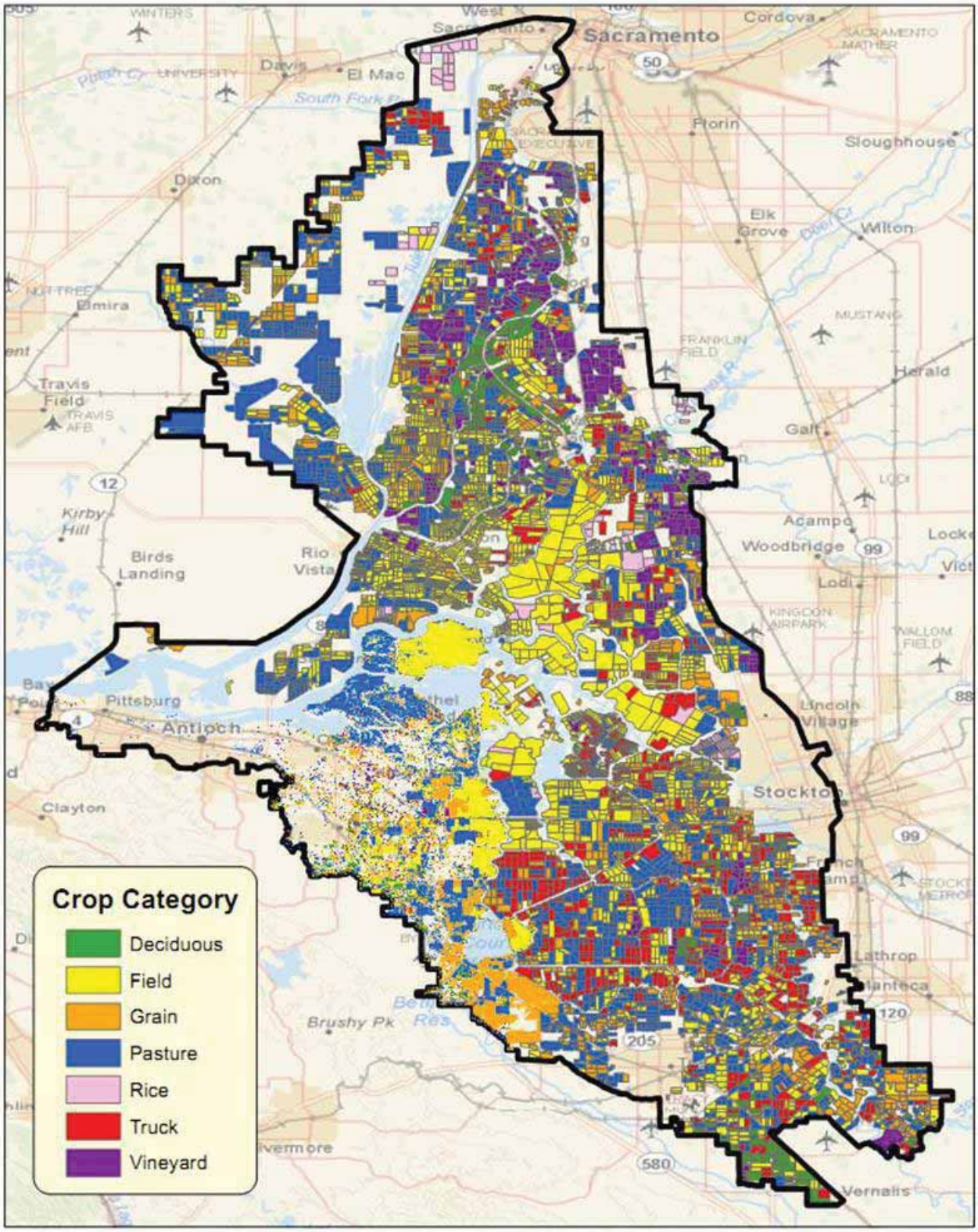


Figure 19 Agricultural Land Cover-2010. (Note: Grazing Land indicated on previous figure.)



2.4 Delta Agricultural Revenues

Total Delta agriculture revenues can be calculated using the acreage analysis described above and multiplying the acreage of each individual crop by the yield and unit price reported in county crop reports. This produces a total of $662 million dollars in revenues from Delta agriculture in 2009. Tables 9 and 10 depict total revenue by crop category in each county and the top revenue-generating Delta crops.

Table 9 Delta Agricultural Revenues, 2009 (in $1000s)

Crop Class	San Joaquin	Sacramento	Yolo	Solano[1]	Contra Costa[2]	Alameda	**TOTAL**
Deciduous	25,118	41,738	3,345	1,347	8,667	498	**80,713**
Field	65,453	17,164	4,860	9,331	19,327	7	**116,142**
Grain	14,539	2,775	1,618	4,615	288	65	**23,900**
Pasture	46,801	5,902	5,753	8,113	3,084	196	**69,849**
Truck	217,491	19,148	11,570	3,389	13,871	258	**265,727**
Vineyard	32,099	28,474	32,718	5,042	6,657	6	**104,996**
Grazing Land[3]	9	57	230	372	46	40	**754**
TOTAL	**401,510**	**115,258**	**60,094**	**32,209**	**51,940**	**1,071**	**662,082**

[1] Crop value calculations use 2010 field borders acreage

[2] Values include all reported county crop report acreage due to lack of reported field borders

[3] Grazing land acreage estimated from 2008 FMMP data and valued at $20 acre.

Figure 20 Average Revenues per Acre

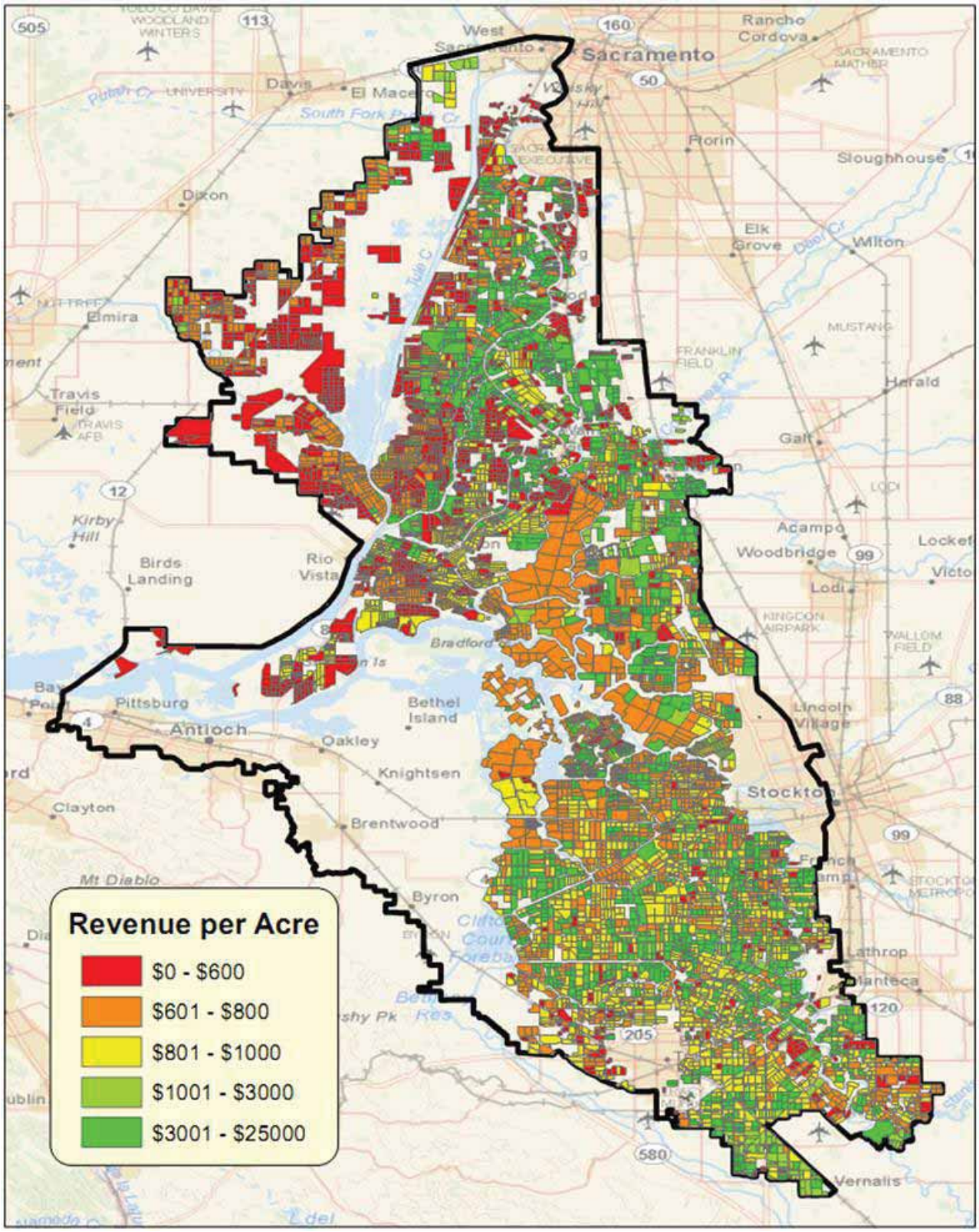


Table 10 Top 20 Delta Crops by Value, 2009

	Crop	Value	Acreage
1.	Processing Tomatoes	$117,242,615	38,123
2.	Wine Grapes	$104,990,142	30,148
3.	Corn	$92,975,715	105,362
4.	Alfalfa	$66,027,076	91,978
5.	Asparagus	$50,050,037	7,217
6.	Pear	$36,746,649	5,912
7.	Potato	$28,605,465	3,353
8.	Blueberry	$25,255,917	1,097
9.	Wheat	$17,549,215	34,151
10.	Cherry	$11,490,843	1,855
11.	Almond	$8,776,101	3,121
12.	Walnut	$9,453,874	2,902
13.	Watermelon	$7,953,590	1,717
14.	Pumpkin	$7,926,038	2,104
15.	Cucumber	$7,866,553	3,529
16.	Rice	$6,822,488	4,874
17.	Pepper	$6,247,592	1,289
18.	Apple	$4,455,826	846
19.	Oat	$4,195,540	15,847
20.	Bean, Dried	$3,990,318	5,493

3 Outcomes and Strategies Under Baseline Conditions

3.1 Long-run Forecasted Land Allocation

Important Note: The technical modeling in this section is being updated with additional data and explanation. While there is no change to the overall trend towards higher-value crops, the details of the projections could change significantly in the September draft.

A multinomial logit model produced a future allocation forecast, conditional on its current land allocation and other exogenous variables, including soil quality, salinity, temperature, slope, and field size. The model generates estimates of the probability of observing a given crop type in each specified field over a long-term time horizon. It was trained on a dataset of over 6,000 individual crop fields for which annual crop data was tabulated for each year from 2006 through 2010.

Table 11 Long-run Land Allocation Forecast

	Deciduous	Field	Grain	Pasture	Truck	Vineyard
Current Land Allocation	4.01%	34.34%	12.30%	31.06%	11.02%	7.28%
Forecasted Land Allocation	4.90%	26.17%	10.04%	30.09%	21.57%	7.23%
Land Allocation Change	+0.89%	-8.16%	-2.26%	-0.97%	+10.55%	-0.05%
Relative Crop Change	+22.12%	-23.77%	-18.37%	-3.11%	+95.76%	-0.73%
Acreage Change at 2010 Production Levels	+3,725	-34,269	-9,484	-4,056	+44,304	-223

The preliminary results of the long-run land allocation forecast are contained in Table 11 above. Significant growth is predicted in truck and deciduous crops, with the largest decline among field and grain crops. This indicates a trend towards increased planting of high-value crops, which would lead to an estimated $114 million increase in total agriculture revenue assuming current crop category mix and 2009 prices. Forecasted revenue changes are illustrated in Table 12 below.

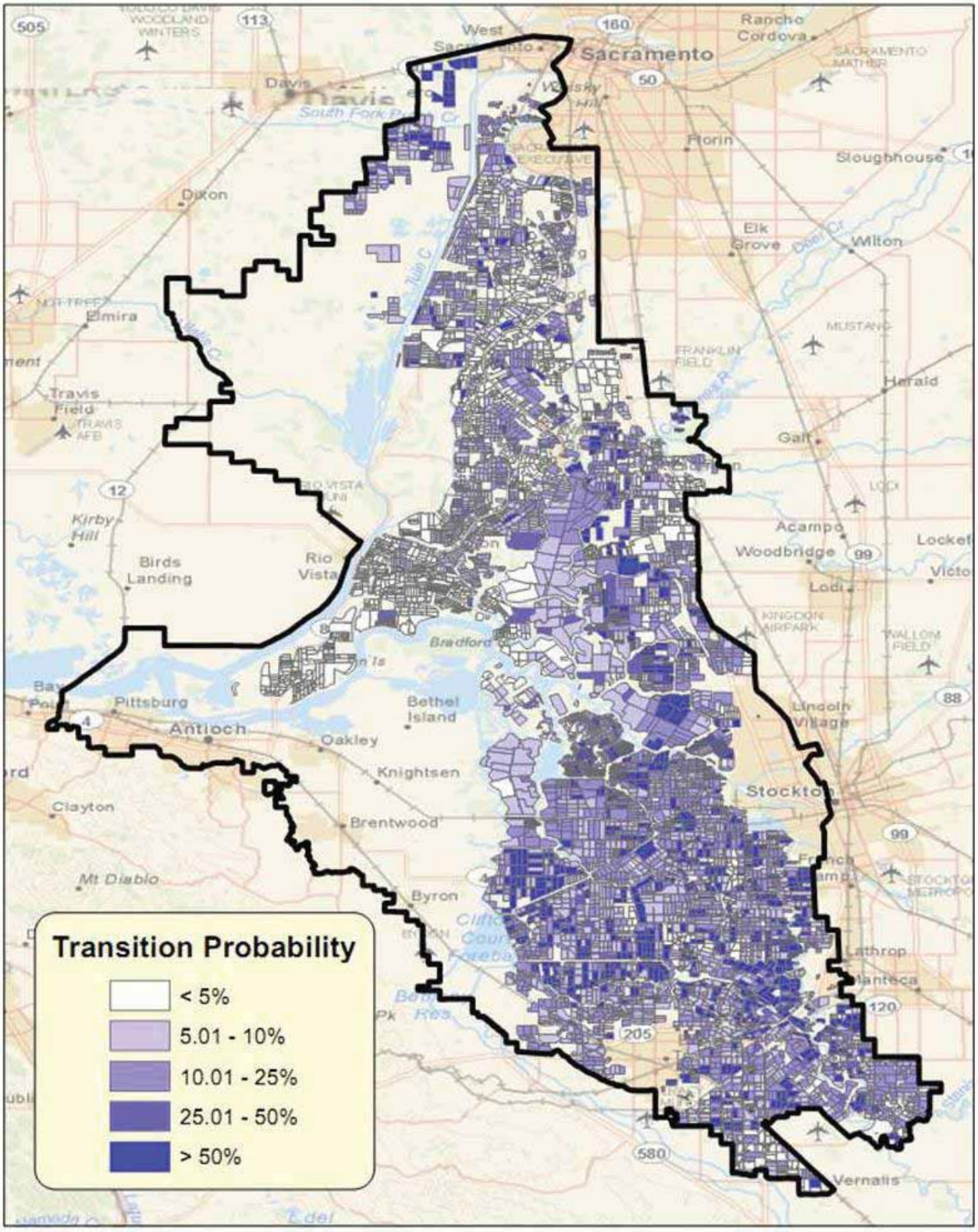
Many future crop allocations are possible, and these results merely depict the most likely allocation calculated by the model. A 10% shift towards higher-value crops over several decades is not a rapid shift and consistent with crop shifts in other areas throughout the Valley. Some stakeholders have stated an expectation that there will be somewhat more vineyard growth and less truck crop growth than the model predicts, but agree with the general prediction of modest growth in higher-value crops over time if farm land and water quality are protected.

Table 12 Long-run Agricultural Revenue Forecast

Crop Category	Current Revenue ($1,000s)	Forecasted Revenue ($1,000s)	Revenue Change ($1,000s)
Deciduous	80,215	88,939	+8,724
Field	116,135	82,996	-33,139
Grain	23,835	19,730	-4,105
Pasture	69,653	83,295	+13,642
Truck	265,469	395,627	+130,158
Vineyard	104,990	104,659	-331
TOTAL	**660,297**	**775,246**	**+114,949**

A map depicting field-level transition probabilities to truck crops is shown in Figure 21 on the following page. The map includes the individual transition probabilities of each field for which sufficient field borders data is available. Most predicted future truck crops are located in the southern end of the Delta, with very few predicted in the western region near the inlet to the bay. This is largely explained by greater salinity levels in the western Delta that adversely affect the yields of processing tomatoes and other common truck crops.

Figure 21 Probability of Long-run Transition to Truck Crops



4 Impact of Policy Scenarios

4.1 Salinity Impacts of Isolated Conveyance Facilities

Important Note: The technical modeling in this section has been updated with a longer time-series of data for key areas of San Joaquin County and some adjustments to the model in response to constructive suggestions from other economists. The revised results continue to show significant salinity impacts of a similar scale to those discussed below, although the details will change in the September draft. While the revised results will strengthen and add precision to the analysis, they are not expected to have any impact on the recommended actions in the Plan.

The introduction of isolated conveyance facilities is expected to significantly increase salinity levels, particularly in the western and southern Delta. Rising salinity levels would lead to decreased yields for many sensitive crops, and alter the future agriculture landscape of the Delta. Overall, the changes brought on by increasing salinity would be expected to have a starkly negative effect on Delta agricultural revenues. The maps from previous sections reveal that many of the highest-value crops are concentrated in the south Delta, and under current conditions acreage of those crops is expected to increase, bringing greater economic benefits to the Delta region. However, these crops also tend to be the most sensitive to increases in salinity, and thus the most vulnerable to the water quality changes brought on by the introduction of isolated conveyance facilities.

Incorporating measurements of salinity throughout the Delta as an exogenous variable in the multinomial logit model creates an ability to capture the marginal impacts on crop choice of changes in salinity. These observations then can be used to predict how the agricultural composition of the southern Delta would change if it were subjected to various scenarios of increasing salinity. The calculations of crop production can then be used to estimate impacts on agricultural revenues.

4.1.1 Salinity Data

For the purposes of baseline salinity modeling, salinity data has been collected for over 50 sites in the Delta region. An analysis of salinity impacts required the creation of a variable representing average salinity on an annual basis. Based on information gained in a working group and further consultation with Delta farmers, a decision was made to use a value for the average salinity observed between May and August, when sensitive crops are most vulnerable to salinity changes in the Delta. Salinity is represented using measures of electroconductivity, in units of micro Siemens per centimeter.

The modeling also required the ability to map salinity values to each individual crop field. In order to predict these values, salinity measurements were averaged across all observation sites in a three-mile radius of each crop field. The measurement value of the nearest station was used for fields without multiple monitoring stations within that radius. This generated standardized estimations of salinity for fields throughout the Delta using a replicable technique. A map of the salinity observation stations used as inputs is depicted in Figure 18, and the sources of the station data are described below.

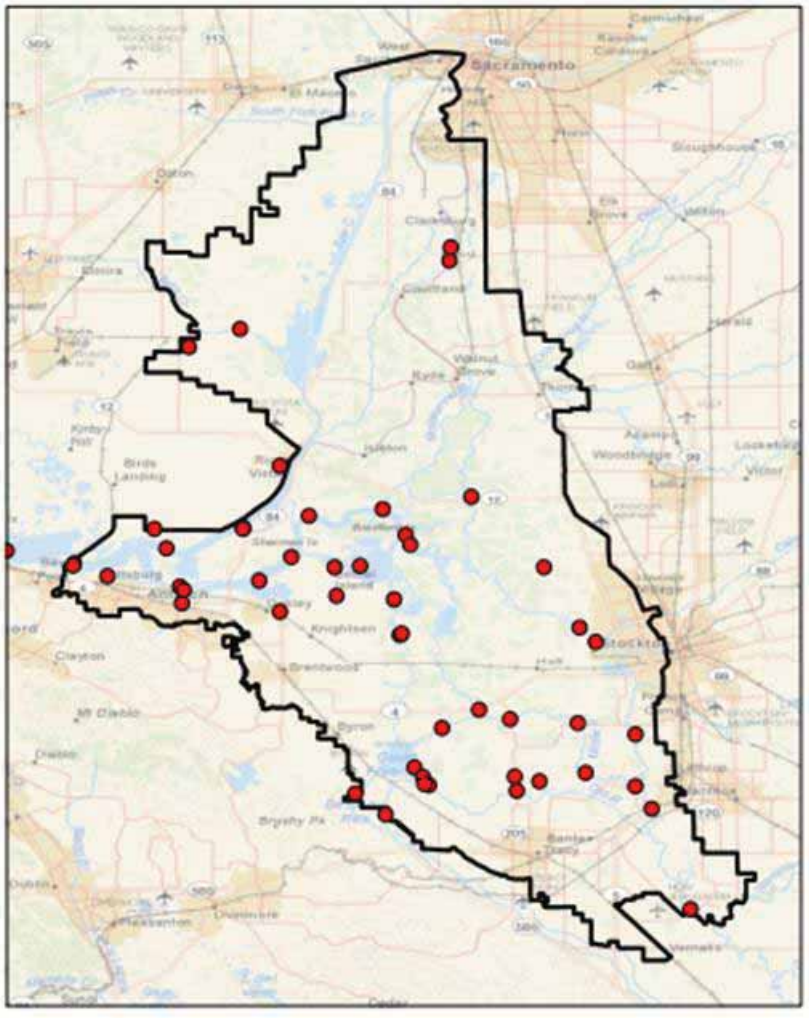
Interagency Ecological Program (IEP)

The IEP samples discrete water-quality data at 19 sites throughout the Delta. The sites are chosen in an attempt to represent the major inflows and outflows of the Delta, with new data sampled monthly. All reported observations undergo a detailed quality assurance process prior to being made publicly available. Sampling sites are mapped in GIS using longitudinal and latitudinal coordinates provided by the IEP.

California Data Exchange Center (CDEC)

Additional salinity data is collected from 45 Delta water monitoring stations reported through the CDEC. The sites are maintained by a variety of organizations, including the California Department of Water Resources, the U.S. Bureau of Reclamation, and the U.S. Geological Survey. The sites are sampled daily, and the monthly average is taken based on reported daily values.

Figure 22 Salinity Observation Stations



4.1.2 Salinity Modeling

Tables in Appendix E give more detail about how average salinity varies across space and years in the Delta. It is important to emphasize that the data is presented here as a season long average and masks important spikes that often occur during years when the average is considerably lower. The five year sample for this preliminary modeling includes three dry years with very high salinity from 2007 to 2009, whereas salinity was significantly lower in 2006 and 2010. During 2008, average salinity levels in most of the Delta were 60% to 80% higher than in 2006. In the north Delta, average salinity is less than 200 ec in most years and there is relatively less variation between years. In contrast, the south Delta averaged 652 ec in 2008 and 361 ec in 2006, with some areas averaging 800 ec or more in 2008 and 2009. Thus, the south Delta experiences significantly higher levels of salinity and more variation than the north Delta. This reflects many factors, including the significant differences in water quality between the Sacramento and San Joaquin Rivers.

For preliminary calculations of impacts, scenarios were established for percentage increases in salinity for the southern Delta regions, comprising fields within BDCP conservation zones 6 through 9. In reality, salinity would not increase uniformly across the region, and future iterations of the model with improved estimates of salinity increases will generate more precise results. However, the current predictions in Table 13 below give a rough estimate of the magnitude of agricultural revenue impacts associated with potential salinity increases.

Table 13 Forecasted Crop Distribution Changes from Increasing Delta Salinity

Salinity Increase	Forecasted Crop Allocation						Annual Crop Revenues ($1,000s)
	Deciduous	Field	Grain	Pasture	Truck	Vineyard	
0%	4.90%	26.17%	10.04%	30.09%	21.57%	7.23%	775,246
25%	4.91%	27.13%	10.85%	30.21%	20.04%	6.86%	747,063
50%	4.90%	28.05%	11.70%	30.24%	18.59%	6.52%	720,082
100%	4.84%	29.76%	13.55%	30.02%	15.93%	5.90%	669,658
200%	4.55%	32.53%	17.72%	28.68%	11.62%	4.90%	584,056

The model predicts a large shift from high-value truck and vineyard crops to low-value field and grain crops should salinity levels rise in the south Delta. This shift has potentially significant revenue impacts on Delta agriculture, and expected losses in tomatoes and wine grapes could be further amplified by downstream impacts on local canneries, wineries, and other processing facilities. The forecasted shifts in crop distribution are intuitive, as they reflect the salt sensitivity of the dominant Delta crops in each crop category. Processing tomatoes, the dominant truck crop in the Delta, are salt-sensitive, as are wine grapes. Both are expected to decline, while more salt-tolerant grain and field crops are expected to increase their acreage. Pasture crops range in their sensitivity to salt, and a decline in moderately-sensitive alfalfa crops may be balanced out by an increase in more tolerant clovers and grasses. Deciduous crops are largely

salt-sensitive but are mainly located outside of areas in which isolated conveyance facilities would have major salinity impacts.

It is very difficult to determine the potential impacts of isolated conveyance at this time. There have been some reports that the isolated facility can and will be operated in compliance with current D-1641 standards in the south Delta of 700 ec, or proposed standards of 1000 ec. However, as noted in Chapter 5, the current BDCP does not include south and central Delta standards as it does for the north and west Delta. Thus, it is argued that the lack of standards combined with the necessity to pay for the over $12 billion facility through revenue from water sales will create pressure to operate the facility in a way that could lead to even larger increases in salinity. Nobody knows what will happen and the stakes are high for the Delta economy. Although some have commented that it is inappropriate to estimate impacts given these levels of uncertainty, these initial estimates are intended to stimulate additional research, analysis and discussion of this very critical issue.

One possible interpretation is that isolated conveyance will result in a typical year looking like 2008 when most monitoring stations in the south Delta were near the 700 ec standard. This would be a roughly 25% increase over the average levels between 2006 and 2010, and about a 50% increase over lower salinity years such as 2006 and 2010. According to the results in Table 9, the resulting loss in crop revenue would range from $28 million to $54 million. The proposed 1000 ec standard is a 42% increase over these levels, and would push the average year salinity increase to nearly 100%, a roughly $100 million loss. If water quality were to deteriorate even further, the losses would grow as illustrated by a predicted $191 million crop loss under a tripling of south Delta salinity.

The scenario in Table 9 discussed above measures the potential impacts from the predicted levels of future crop production. A more conservative scenario was also estimated that measures the potential loss from current levels of crop revenues and restricts the impacted area by eliminating conservation zone 9 and also conservation zone 6 in the most conservative scenario. Compared to a baseline of 2010 salinity, this approach estimates losses of $21 million to $34 million if all the impacted areas moved to average levels of 700 ec and losses ranging from $34 million to $63 million if all the impacted areas moved to the proposed standard of 1000 ec.

It is also important to note that the BDCP estimates that roughly 8,000 acres will still be required for a tunnel conveyance system, even though the land requirements are much lower than a surface canal. Most of the affected acres are in relatively high value agricultural lands in the North Delta that currently average about $2,000 per acre in revenue. Using detailed acreages allocated across crop classes in the draft BDCP, the land consumption of the isolated conveyance project would result in an additional $10 to $15 million annual loss to Delta agricultural revenues.

From the discussion above, it is clear that there is much uncertainty regarding the effects of isolated conveyance and that the potential losses for the south Delta are significant even under

the lowest scenarios. At this time, a conservative estimate of revenue losses in a range between $20 million and $65 million from salinity plus $10 to $15 million from land consumption is a reasonable estimate for discussion. This range is below the estimate of $70 million in Delta farm revenue losses from a peripheral canal made by Howitt in 2007.[61] However, there is a significant risk that losses could be much higher, especially given the lack of specific south Delta water quality standards in the draft BDCP and the expected political and financial pressure to weaken any future standards.

4.2 Loss of Agricultural Value from Habitat Conservation Scenarios

As outlined in Chapter 5, this report seeks to address impacts of four major conservation measures proposed by the BDCP. An extremely precise examination of agriculture impacts is not currently possible due to the lack of specificity provided in the BDCP as to where lands would potentially be conserved or restored. The best spatial approximation of targeted areas is provided by the BDCP's delineation of Conservation Zones and Restoration Opportunity Areas (ROAs) for which conservation investments are proposed. Replicating the spatial extent of these zones and analyzing the agricultural landscape of each gives an estimate of the impacts on agriculture that each conservation measure would entail.

Table 14 below illustrates the total agricultural acreage and average revenue generated by crops fields in each of the BDCP's conservation zones. In addition, a list of the conservation measures with significant impacts in each conservation zone is provided. A map of Delta crop fields and their associated conservation zone is included in Figure 23.

Table 14 Agricultural Composition of BDCP Conservation Zones

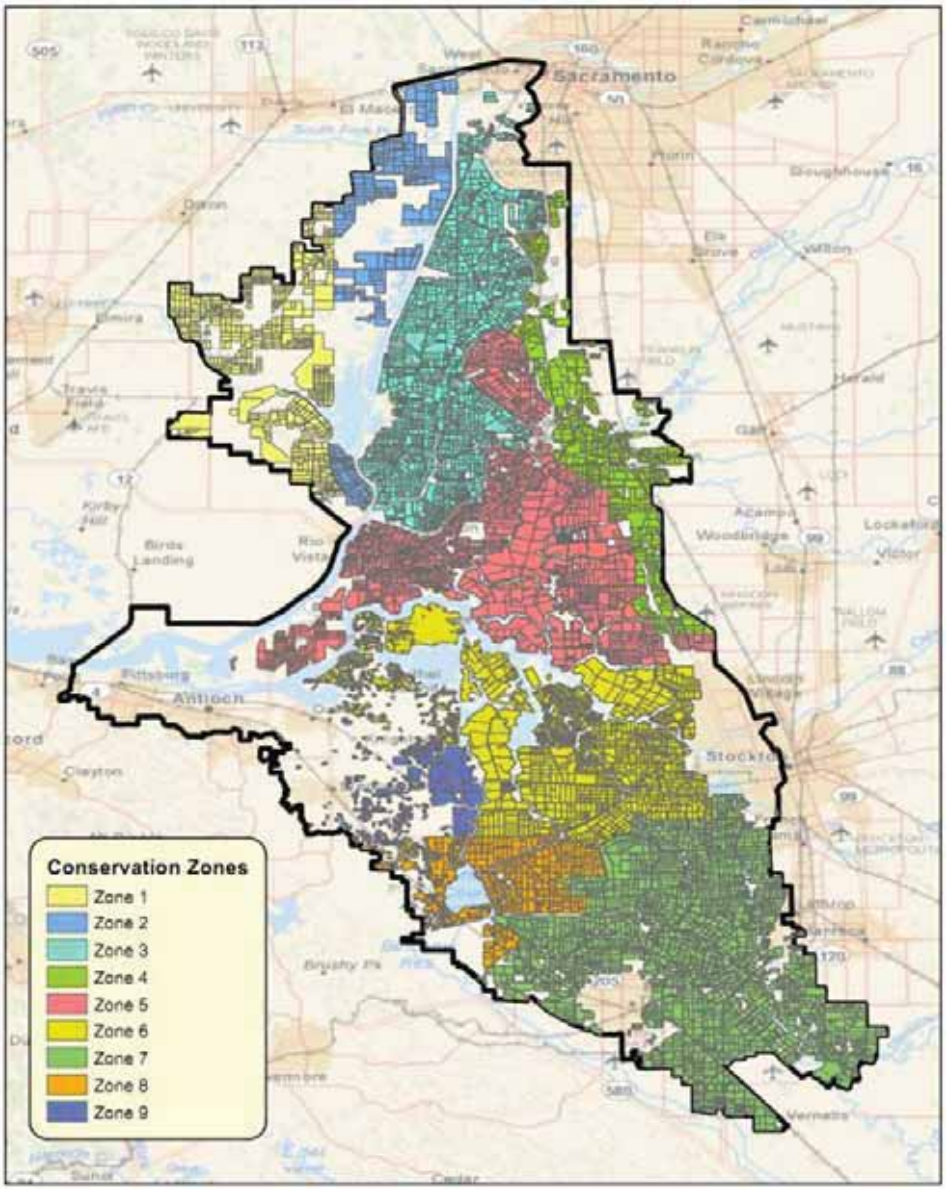
Conservation Zone	Agricultural Acreage (2010)	Revenue per Acre (2009)	Relevant Conservation Measures
1	31,030	$463	CM3, CM4
2	14,064	$802	CM2, CM3, CM4
3	59,011	$1,474	CM6
4	26,441	$2,075	CM3, CM4, CM6
5	75,239	$1,838	CM3, CM4, CM6
6	71,219	$1,885	
7	89,716	$1,823	CM3, CM4, CM6
8	27,595	NA	
9	15,809	NA	

[61] Howitt, Richard. "Delta Dilemmas: Reconciling Water-Supply Reliability and Environmental Goals." *Agricultural and Resource Economics Update* 10(4)(2007):1-4.

4.2.1 Yolo Bypass Fisheries Enhancement

Major impacts on agriculture from Yolo Bypass Fisheries Enhancement will come from the potential acquisition of lands through fee-title or conservation and flood easements. The largest source of revenue in the affected conservation zone comes from rice fields located along the northern region of the Yolo Bypass, and the use of rangeland could also be impacted. Total agricultural revenue in the area is currently estimated at about $12 million, and the draft BDCP estimates flood easement costs would average about 25% of current land values. Based on this, a rough estimate of annual crop revenue impacts is $1 million to $5 million annually. Yolo County is working with BDCP to develop a proposed project that minimizes or avoids impacts to existing land uses. Like other preliminary cost estimates for habitat measures, the estimated impacts could change as plans change over time.

Figure 23 BDCP Conservation Zones



4.2.2 Natural Communities Protection

The Natural Communities Protection strategy has several elements, the most significant of which is the acquisition of 32,000 acres in "wildlife friendly" agricultural easements. While some specific targets are cited in the BDCP, the general outline of site selection methodology is not sufficient to currently identify with certainty which agricultural areas may be most affected. In addition, the specific terms of the easements are not known, and the draft BDCP contains a very wide range of potential easement costs as a percentage of current land values.

Table 15 below provides a more detailed overview of acreage revenue for Delta cropland. The average revenue per acre of all Delta agriculture is $1,755, while the median is much lower, $818. This range reflects the range of potential impacts of agricultural conservation easements in the Delta. Easements may target relatively low value, wildlife-friendly field and grain cropland to make slight modifications in operations and protect them in these uses. In this case, the agricultural impacts are relatively small. Alternatively, the easements could attempt to convert land used for higher-valued crops such as tomatoes and wine grapes to more wildlife-friendly, lower-valued crops. This more aggressive scenario could generate significant losses of tens of millions of dollars. Considering all this information, a preliminary estimate of agricultural losses is a very wide range of $5 million to $43 million annually.

Table 15 Agricultural Revenue Distribution

Quartile	Revenue per Acre (2009)
25%	$653
50%	$818
75%	$3,000
100%	$23,378
Mean	**$1,755**

4.2.3 Tidal Habitat Restoration

Of the major conservation measures addressed in this report, Tidal habitat restoration has the most clearly defined geographic areas and restoration targets. The agricultural fields contained in each Restoration Opportunity Area (ROA) are shown in Figure 24, with their acreage and value in each region depicted in Table 16 below. The BDCP outlines various restoration targets to be achieved over the next 40 years, with a final target of 65,000 restored acres in the Delta and Suisun Marsh. In addition, there are minimum values for acreage in each of the four ROAs which must be restored, as shown in Table 16. A minimum of 7,000 acres is targeted for Suisun Marsh which lowers the maximum target for tidal habitat in the Delta to 58,000 acres.

Figure 24 BDCP Restoration Opportunity Areas

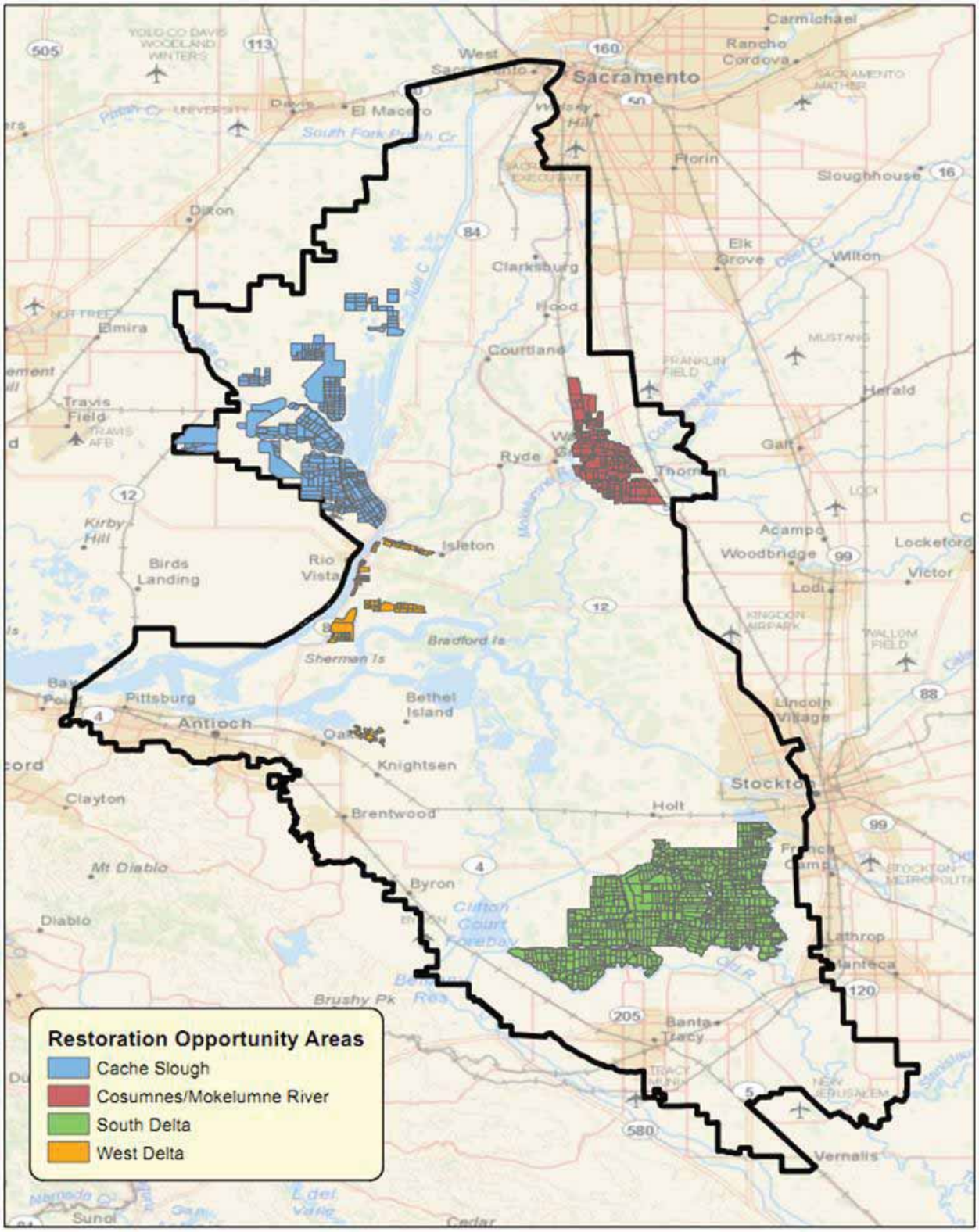


Table 16 Agricultural Composition of BDCP Restoration Opportunity Area

Restoration Opportunity Area (ROA)	Total Acreage	Agricultural Acreage (2010)*	Minimum Restoration Target (Acres)	Revenue per Acre (2009)
Cache Slough Complex	49,167	19,854	5,000	$491
Cosumnes/Mokelumne River	7,805	7,840	1,500	$2,175
South Delta	39,969	34,914	5,000	$2,151
West Delta	6,178	2,587	2,100	$1,279
TOTAL	**103,119**	**65,195**	**13,600**	**$2,014**

*Values may be slightly inflated due to large fields centered within the ROA which extend past its borders.

As can be seen in Table 16, in some regions even the minimum restoration targets will require the acquisition of land currently used in crop production. In addition, both the Cosumnes/Mokelumne River ROA and the South Delta ROA are centered in some of the highest revenue agricultural areas of the Delta. Even if over 50,000 acres were restored in Suisun Marsh so that only the minimum restoration targets were reached in the four Delta ROAs, total agricultural revenue loss would be about $18 million per year with nearly $11 million of the total loss occurring in the South Delta. If only the minimum were restored in Suisun Marsh and the remaining 58,000 acres distributed across the Delta, the estimated revenue loss would reach $77 million per year with about a $46 million loss in the South Delta.

The wide range of potential agriculture losses ranging from $18 million to $77 million annually illustrate the risk and uncertainty this conservation strategy poses for Delta agriculture, particularly in the South Delta. Compared to the other conservation measures, the tidal marsh restoration strategy entails by far the largest necessary direct impacts on Delta agricultural production, and also has some of the highest direct implementation costs for BDCP. The BDCP currently states that the majority of these targeted lands will be determined "based on land availability, biological value, and practicability considerations." The absence of agricultural impacts from the described methodology is a notable omission considering the potential implications for the Delta economy. Targeting criteria that avoids high-value agriculture lands and reduced target acreages, particularly in the South Delta, should be considered.

4.2.4 San Joaquin River Floodplain Restoration

CM5 calls for the restoration of 10,000 acres of seasonally-inundated floodplain habitat over a 40-year period, with 1,000 acres restored in the first 15 years. No specific regions are outlined, though the BDCP notes that "the most promising opportunities for large-scale restoration are in the south Delta along the San Joaquin River, Old River, and Middle River channels…" These areas fall almost entirely within conservation zone 7, which is largely occupied by high-value alfalfa and tomato crops and has an average per-acre revenue of $1,823. In addition, the identified areas are almost entirely in agricultural production, and a large proportion of the restored floodplain would almost certainly affect land currently in production. Based on current

production, the San Joaquin River Floodplain Restoration could reduce annual agricultural revenue by $15 million to $20 million per year.

An alternative proposal focused on enhancing the flood bypass at Paradise Cut has been developed cooperatively between environmental groups and local Delta landowners. This proposal would generate significant flood control and ecosystem benefits while limiting agricultural impacts to 2,000 acres, thereby reducing agricultural impacts by up to 80%. The alternative proposal is recommended in the fourth draft of the Delta Stewardship Council's Delta Plan.

4.3 Loss of Agricultural Value from Open Water Scenario

The central Delta open water scenario discussed in chapter 5 would result in a loss of agricultural production on the flooded islands. The impacts can be quantified simply by looking at the agricultural farmland currently in production on each island. If the five islands were flooded, assuming Empire Tract is not included, over 10,000 acres would be lost, with a corresponding loss of around $8.4 million dollars in direct revenues per year. The islands are largely composed of low-value field crops, with average revenue per acre significantly below that of the Delta as a whole. A summary of the affected islands is depicted below in Table 17.

Table 17 Five Island Agricultural Composition

Island	Agricultural Acreage (2010)	Total Revenue (2009)	Revenue per Acre (2009)
Mandeville	2,345	$2,198,583	$1,117
Medford	365	$279,797	$715
Quimby	629	$487,720	$776
Venice	2,587	$2,008,844	$765
Webb	4,469	$3,467,869	$776
TOTAL	**10,395**	**$8,442,813**	**$969**

5 Economic Impact of Delta Agriculture

The previous sections focused on the value and composition of crop production in Delta agriculture. To calculate the economic impact of agriculture in the Delta, two additional areas needed to be considered: 1) the value of animal agriculture in the Delta, and 2) the output of local food and beverage manufacturing firms that are located in the region because of Delta crop output.

5.1 Animal Production in the Delta

Animal and animal product output in the Delta is more difficult to estimate than crop production. It is clear that the Delta is not as oriented towards crop production as many other areas in the Central Valley, although a significant amount of its crop production is alfalfa and field crops that are consumed by animal enterprises outside the Delta. Other reports by the Department of Water Resources and the Delta Stewardship Council White Papers have estimated animal-related output in the Delta at about $90 million per year, significantly less than crop production.

Estimates produced for this study are very similar. Enterprise data from Dun and Bradstreet and NETS were used to identify dairy, cattle, and other animal production enterprises located within the legal Delta, and this figure was compared to the total number in the counties. The percentage of animal enterprises in each county located in the Delta was applied to the total animal production in the crop reports for each of the five Delta counties, resulting in an estimate of $93 million in animal output, shown in Table 18.

Table 18 Animal Output in the Delta

Animal Output	Value
Cattle	$24,097,110
Sheep, Poultry, other Livestock	$3,160,977
Milk	$64,322,406
Wool	$94,628
Apiculture	$1,712,879
Total Animal and Animal Products	**$93,388,000**

5.2 Local Source Dependent Food and Beverage Manufacturing

Food and beverage manufacturing is an important economic sector in California and the five Delta Counties. Some of that manufacturing only exists in the region because of local farm outputs, whereas other enterprises are located in the region to serve local consumers or for other reasons. To be conservative, only food and beverage manufacturing (where a clear and strong link to local production could be established) were used. Other factors considered included geographic distribution of food manufacturing relative to local production throughout the state, as well as the import of grains and other crops into the state from other regions. It was determined that many of the agriculture-related manufacturing enterprises in the five counties--such as grain milling, snack foods, cereal manufacturing, pet food, cheese manufacturing, animal slaughtering, breweries, and ethanol production—can't be strongly attributed to the presence of Delta agriculture. Similarly, although Delta crops are definitely consumed in large quantities by dairies outside the Delta, these dairies also use grain and alfalfa transported significant distances and could increase the use of these imported feeds if necessary, although at higher cost. Thus, to be conservative, dairy production outside the Legal Delta was not attributed to Delta agriculture.

However, two important regional industries can be strongly linked to local production: fruit and vegetable canning and pickling, and wineries. These local industries are heavily supported by the Delta's two highest value crops, processing tomatoes and wine grapes. Delta wine grapes are roughly 5 percent of California production by both weight and value. The prices are similar to state averages, much higher than other areas of the Central Valley but much lower than premier growing areas such as Napa and Sonoma. Winery capacity in the Delta and the five Delta counties is small relative to local production, but Napa and Modesto winery capacity is very high relative to local production. The data and interviews with local producers support that Delta wine grape production is supporting significant winery output in nearby Napa County. Cannery production capacity in the five Delta counties is much stronger compared to local

output than winery capacity, although some local production is likely supporting a large cluster of processing facilities in adjacent Stanislaus County. Using state and regional production shares of processing tomatoes and other fruits and vegetables commonly canned and pickled, it is estimated that $722 million of output from the fruit and vegetable canning, pickling, and drying industry in the five county Delta region is dependent on Delta agriculture. Using state and regional shares of wine grape production from the Delta, it is estimate that $181 million of winery output in the five Delta counties is dependent on Delta wine grapes, and $541 million of winery output in adjacent counties (mostly Napa) is sourced from the Delta.

5.3 Economic Impact Estimates

The IMPLAN 3 model calibrated to 2008 regional and statewide economic data was used to estimate the overall economic impact of Delta agriculture. See Appendix E for a description of the IMPLAN model and formal definitions of terms such as direct, indirect, and induced effects. As has been done in previous studies of the impact of water supply reductions on south of Delta agriculture, and following a methodology initially proposed by UC-Davis agricultural economists, the default IMPLAN production functions were adjusted to account for the unusually high use of contract labor in California agriculture. The production functions were adjusted to ensure that virtually all (97 percent) of the output of the agricultural service sector was utilized by the regional agriculture industry, a methodology that recently yielded accurate predictions of the employment effects of the 2009 drought in the San Joaquin Valley.

For the five county economic impact model, Delta agricultural production, and Delta-dependent food processing and winery production was distributed across IMPLAN production sectors according to Table 19. In the initial model, only the impacts of the $753 million in direct agricultural production were modeled. As shown in Table 20, the approximately $660 million in Delta crop production and $90 million in Delta animal and animal product revenue has an economic impact of 9,250 jobs, $635 million in value added and $1.3 billion in output in the five Delta counties. Table 21 shows that across all of California, the economic impact of Delta agriculture is 12,360 jobs, $761 million in value added, and $1.5 billion in output without including upward linkages to canneries and wineries.

To get a more complete picture of the full economic impact, the impact of locally linked food manufacturing in fruit and vegetable canning and wineries were included. These upward linkages must be estimated separately, because the indirect effects of the IMPLAN model only includes backwards linkages from purchased inputs. To avoid double counting impacts from the initial stage, the indirect effects attributed to the purchase of crops as inputs to canneries and wineries were netted out of the results. The total five county economic impacts are displayed in Table 22. Delta agriculture supported 13,700 jobs, $1.11 billion in value-added, and $2.77 billion in output. For the California economic impact model, the additional $541 million of Delta dependent winery production from adjacent counties was add to the totals. The economic impact rises from this extra production, and also because the indirect and induced effects grow when considered on a statewide rather than five-county basis. Table 23 shows that across the state of California, Delta agriculture supports nearly 23,000 jobs, over $1.9 billion in value added, and over $4.6 billion in output.

Table 19 Agriculture Related Output Used for the 5 County IMPLAN model

Industry	Output Value (millions $)
1 Oilseed farming	3.3
2 Grain farming	136.7
3 Vegetable and melon farming	238.9
4 Fruit farming	191.7
5 Tree nut farming	20.1
10 All other crop farming	69.7
11 Cattle ranching and farming	27.2
12 Dairy cattle and milk production	64.3
14 Animal production, except cattle and poultry and eggs	1.8
Locally Linked Processing in expanded analysis	
54 Fruit and vegetable canning, pickling, and drying	722
72 Wineries	180.5 in Delta 722 statewide

Table 20 Economic Impact of Delta Agriculture on 5 Delta Counties (not including processing)

Impact Type	Employment	Labor Income	Value Added	Output
Direct Effect	4,005	$136,405,744	$338,921,900	$753,700,032
Indirect Effect	3,826	$143,749,040	$176,479,000	$348,913,376
Induced Effect	1,419	$64,282,712	$119,500,200	$203,569,088
Total Effect	**9,250**	**$344,437,504**	**$634,901,100**	**$1,306,182,528**

Table 21 Economic Impact of Delta Agriculture on California (not including processing)

Impact Type	Employment	Labor Income	Value Added	Output
Direct Effect	4,955	$147,794,976	$338,921,800	$753,700,032
Indirect Effect	5,199	$191,501,232	$222,314,000	$411,410,112
Induced Effect	2,206	$110,576,296	$199,624,100	$351,857,728
Total Effect	**12,360**	**$449,872,512**	**$760,860,000**	**$1,516,967,936**

Table 22 Economic Impact of Delta Agriculture on 5 Delta Counties

Impact Type	Employment	Labor Income	Value Added	Output
Direct Effect	5,465	$237,501,354	$507,262,180	$1,605,036,480
Indirect Effect	5,685	$269,323,135	$383,743,710	$796,612,528
Induced Effect	2,560	$116,080,527	$215,710,160	$367,500,362
Total Effect	**13,709**	**$622,905,032**	**$1,106,716,150**	**$2,769,149,432**

Table 23 Economic Impact of Delta Agriculture on California

Impact Type	Employment	Labor Income	Value Added	Output
Direct Effect	6,872	$316,894,592	$612,684,000	$2,098,397,336
Indirect Effect	10,354	$543,196,268	$793,868,280	$1,652,235,400
Induced Effect	5,590	$280,485,258	$506,257,120	$892,533,692
Total Effect	**22,816**	**$1,140,576,112**	**$1,912,809,300**	**$4,643,166,560**

6 Other Agriculture Issues

There has been significant interest in alternative forms of agriculture in the Delta, as well as new approaches to increase agricultural revenue. Many of the ideas have been proposed in Delta Vision and other Delta related plans and reports. Ideas include increased agri-tourism, regional branding and marketing of Delta crops, growing crops for biofuels, subsidence-reversal agriculture, and growing crops for carbon sequestration purposes and the marketing of carbon credits. Some of the ideas are promoted for the dual benefits of ecosystem restoration and reducing flood risks, whereas others are primarily seen as a way to enhance local agricultural income.

Most of these options were evaluated in a recent report by the UC Davis Agricultural Issues Center (AIC) developed for the California Department of Food and Agriculture and presented to the Delta Stewardship Council. In virtually all cases, the AIC report determined that the ideas have very limited potential to develop a significant market in the Delta. For example, most Delta crops are commodities such as corn and processing tomatoes are commodities for which branding is not effective.

Agritourism, defined as recreational, educational and other visits to working farms, is a small but fast growing source of income for farms in the region. As discussed in the Appendix of the recreation and tourism chapter, agritourism was estimated by USDA to generate $4 million in income for farms in the five Delta counties in 2007. Assuming agritourism in the Delta is proportional to overall agriculture in the county, a roughly 25% share, agritourism generated roughly $1 million in revenue in 2007. An inventory of agritourism enterprises in California maintained by UC cooperative extension (http://www.calagtour.org/) identifies 91 agritourism operations in the five Delta counties, and 12 (13%) of these are located in the Delta. Over half of the Delta agritourism enterprises were in Contra Costa County where there is a cluster of U-pick orchards and other farms open to tourists around Brentwood. Only one of the twenty agritourism locations in San Joaquin County was in the Delta, but it was a very large attraction at Dell'Osso Family Farm adjacent to Interstate 5 near Lathrop that is estimated to draw over 100,000 visitors each fall to its corn maze and other attractions. Currently, it appears that agritourism is only significant in the suburban edges of the Delta secondary zone

A January 2011 report prepared for the Nature Conservancy examines the potential of carbon capture wetland farms and low carbon agriculture in the Delta.[62] Although carbon capture wetland farms could generate environmental benefits and potentially reverse subsidence on Delta islands, the report casts doubt on whether carbon capture farming is economically viable, although the authors encourage large scale demonstration projects to further research the potential. Specifically, the authors state:

> "Our analysis illustrates that Carbon Capture Wetland Farms are unlikely to provide a clear incentive to both landowners and investors without either fairly high carbon prices or some type of grant or payment scheme to subsidize some of the costs of conversion and annual management." (p. 106)

The report also details other problems including increased methylmercury, organic carbon, and mosquitos that could have negative impacts on various aspects of the Delta economy. The report discusses other low carbon changes to agriculture including conversion to rice growing and reduced tillage practices that may be more economically feasible. The authors encourage large-scale demonstration projects to more fully research the potential of carbon capture wetland farms.

All of these ideas for alternative agricultural revenues have some potential for the Delta. However, it is important to maintain realistic expectations and not use the ideas to deflect discussion of larger actions within BDCP or the Delta Plan that could have negative effects on Delta agriculture.

[62] A. Merrill, S. Siegel, B. Morris, A. Ferguson, G. Young, C. Ingram, P. Bachand, Holly Shepley, Maia Singer, Noah Hume. 2010. Greenhouse Gas Reduction and Environmental Benefits in the Sacramento-San Joaquin Delta: Advancing Carbon Capture Wetland Farms and Exploring Potential for Low Carbon Agriculture. Prepared for The Nature Conservancy, Sacramento, California. Available at: *(http://www.stillwatersci.com/).*